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This paper describes a training model featuring peer instruction in a functional job-simulated context, as well as the objectives and practical constraints that led to its development. (Author)

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The Development of a Low-Cost Performance-Oriented Training Model

by

Kenneth Weingarten, Jacklyn Hungerland,
Mark Brennan, and Brent Allred

Symposium Presentation at the
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Prefatory Note

This paper was presented by Mr. Weingarten as part of the Human Resources Research Organization's symposium at the annual convention of the American Psychological Association in Miami Beach, Florida, September 1970. The paper describes a training model featuring peer instruction in a functional job-simulated context, as well as the objectives and practical constraints that led to its development.

THE DEVELOPMENT OF A LOW-COST PERFORMANCE-ORIENTED TRAINING MODEL

Kenneth Weingarten, Jacklyn Hungerland,
Mark Brennan, and Brent Allred

Current input of Army personnel under Selective Service poses a challenge for educational technology. Every week, Army training personnel are confronted with incoming classes that must be taught a substantial amount in a short and relatively fixed period of time. The men who arrive for training are likely to be an extremely heterogeneous group with respect to educational background and learning aptitude. Thus, a typical class will have students ranging all the way from functional illiterates to college graduates, and scoring from near the lower limit of the Armed Forces Qualification Test to near the upper limit.

The conventional lecture-centered instructional method, which is characteristic of much Army training, is effective, at best, for a relatively narrow band within the larger educational and aptitudinal spectrum. This band, for which training is oriented, can be shifted to some degree by allocating more or less time or by proceeding in smaller or larger teaching steps. However, it cannot really be broadened unless the training population is subdivided into several homogeneous classes with lectures prepared for each class. This kind of multiple tracking approach would require complicated administrative arrangements, many additional instructors, and a larger physical plant, and in addition, would risk a decline in morale relating to trainee placement. Moreover, this approach cannot furnish a solution to the underlying problem.

The lecture method is a compromise based on unfavorable teacher-student ratios and is not an optimal training method for any educational or aptitudinal subgroup. Even with audio-visual training aids, the method is inclined toward abstraction. In addition, there is an undesirable temporal separation between the presentation of information and the opportunity to practice what is learned, as well as an insensitivity to individual differences to be found even in the most homogeneous groups. For the better educated and brighter segment of the training population, these limitations render the lecture method merely less than optimal; for those at the opposite end of the continuum, the same limitations constitute an increasingly effective barrier to learning. Thus, in order to provide adequate instruction for all segments of this training population, a new training model is needed.

This paper will present a brief description of the training model that has grown out of HumRRO Work Unit APSTRAT. Although the model was developed in the context of military training courses, we believe it to be suitable for a wide range of vocational and educational applications. The code name APSTRAT is derived from the terms "aptitude" and "strategies," and calls attention to one of the goals of the project: to identify or devise a set of instructional principles, methods, and techniques—strategies, that is—that would meet the diverse needs of hetero-aptitudinal training populations. The second goal of the project, which is not identified in the code name, is to combine these strategies in a complete training model and to test this model within the severe practical constraints normally present in a typical Army training course.

Before describing the model itself, let me review the instructional principles we wished to incorporate in the model and the practical constraints that limited our options.

These principles form the core of what may be thought of as the APSTRAT instructional "policy."

Instructional Principles

1. Performance orientation. Significant improvement in training requires a clear specification of what the trainee is expected to learn if he is to perform his job adequately. The training process must focus on these job-performance objectives, and quality control must consist of tests of the trainee's ability to *perform the various tasks that make up the job.*

2. Learning in a functional context. When skills are to be utilized in particular circumstances, trainees will, in general, learn them better and with better retention if those circumstances are present in the learning situation. On-the-job training is the prime example of a method focusing on training in a functional context. This method avoids the temporal separation between the presentation of information and the opportunity to practice what is learned, which is generally unavoidable in lecture-centered training methods.

3. Self-pacing. For various reasons, including differential aptitude, some people are capable of learning faster than others. Instructional methods that fix the pace at which learning must take place will generally leave some students behind and bore others. While the need for self-pacing is somewhat less urgent for "homogeneous" groups (especially those composed of trainees high on the educational and aptitudinal scales), no group of men is ever perfectly homogeneous. Consequently, self-pacing is desirable in any training effort.

4. Insistence on mastery. The weaknesses of fixed-pace training methods are most clearly demonstrated by the frequency with which large numbers of students fail to master the skills they are being taught. Differential achievement in training is the inevitable result of attempts to force everyone to learn at the same rate. But fixed-pace instruction is so commonly practiced that many have come to the conclusion that differential achievement is an inevitable consequence of all training. Experience has demonstrated, however, that when students can proceed at rates appropriate to their various capabilities, the great majority can attain high levels of achievement.

In order to incorporate this property in a training system, provision must be made for determining whether a trainee's performance has reached a stipulated level of mastery before he is permitted to proceed to the next learning task. This kind of rigorous quality control is the *sine qua non* of the APSTRAT model.

5. Rapid and detailed feedback to trainees as to the adequacy of their learning. Training methods that permit only delayed feedback in the form of end-of-cycle exams, for example, tend to compound mislearning and will often produce negative effects on motivation. It is always preferable for trainees to experience a sense of security in what they have already learned before going on to learn something else. This implies that accurate feedback should be presented at the earliest possible moment at each critical step of the learning process. Feedback should, therefore, be both rapid *and* detailed.

6. Rapid and detailed feedback to the instructor as to the adequacy of instruction. The more information an instructor receives about the degree to which trainees are learning what they are supposed to learn, the better he will be able to modify his own procedures in the direction of greater effectiveness and efficiency. The faster he receives this information, the sooner he can make these modifications.

Constraints

These six instructional principles comprise the APSTRAT instructional "policy." Given this policy, the question then arises: how is it to be realized—given expression in a

concrete training model? It is at this point that the question of practical constraints asserts itself.

The constraints may be divided into the problems of cost and the problems of ease and flexibility of implementation.

1. Costs. The operational cost of a training model is always of critical concern, and this concern is greatly amplified when there is interest in wide application. Even moderate increases in cost in a single course cumulate to a substantial sum when many courses or many classes in the same course are involved. Decisions concerning personnel, time, operational equipment, and instructional hardware and software, therefore, are crucial and constitute constraints in the development of the training model.

a. Personnel. Many training courses are already undermanned. If the APSTRAT model were to require a significant increase in instructors, its general utility would be considerably reduced.

b. Time. In general, the proficiency gained as a result of training could be somewhat improved merely by lengthening the training period. However, the normal length of this period in ongoing courses is fixed. The training model, therefore, was to require no extension in training time.

c. Operational equipment. Many training courses are concerned with developing skills in the operation of various types of equipment. These courses are issued such equipment in limited quantities. To be capable of wide application, a training model must be able to function within such limits.

d. Instructional hardware. Many promising instructional innovations require the use of very costly hardware, computer-assisted instruction being a prime case. Of lesser magnitude but still substantial are the costs of television and other audio-visual recording and display equipment. The proper use of such equipment can enhance learning. However, the APSTRAT model was planned under the assumption that large amounts of this expensive equipment would not be generally available and, therefore, should not be required.

e. Instructional software. The production of educational software is extremely time-consuming and costly. High quality, programmed instructional manuals, for instance, may cost more than $3,000 per average hour of learning time. Alterations in training objectives, as a result of changes in equipment, for example, require modifications of instructional materials that are also time-consuming and costly. A model relying heavily on instructional software (even if elaborate hardware were not required for its presentation) would have less general utility than an alternate model that could avoid this expense.

f. Trainee output. Training courses are required to produce, in a stipulated time period, certain numbers of men qualified for jobs. No model would be feasible that reduced this output, either permanently or initially.

In rejecting high-cost options in the development of the APSTRAT model, we do not wish to imply that models choosing these options would not produce dramatic improvements in training effectiveness. Nor do we wish to imply that the high initial costs of such alternatives could not be partially or fully offset by future net savings. While this is a very real possibility, the practical difficulties of carrying out such a program are considerable. A training model that attempts a more effective arrangement of the elements of ongoing training courses, without a substantial increase in cost, would appear to be an alternative well worth exploring.

2. Problems of implementation. The constraints I have so far described are unavoidable and place strict limits on the nature of the training model. A number of additional constraints concerned with facilitating implementation were considered desirable and, therefore, were imposed on the model.

a. Training and orientation of course personnel. Effective operation of the model should not require retraining or extensive orientation of present course personnel.

b. Gradual changeover. Revision of an entire training course presents many difficulties which can be considerably reduced if changeover can be accomplished gradually and concurrently with the ongoing system. If possible, the standard training method should be continued during the period of changeover.

c. Amenability of the model to improvement. When a new training model is launched, additional modifications will almost always be desirable. A model that would tend to "lock in" its initial procedures, making the desired improvements difficult to accomplish without overhauling the entire system, may prevent these improvements or lead to the rejection of an otherwise promising method of training. It was seen as urgent, therefore, to build into the APSTRAT model an ability to incorporate improvements without discontinuing operation.

There would have been considerable leeway available in designing a training model that would incorporate the desired instructional strategies if it were not for the severe restrictions of cost constraints. Given these constraints, the model would have to be structured principally from resources available in the present training courses—such as instructors, trainees, and operational equipment.

Under these circumstances, the only available medium of instruction is the "live" instructor, and there are too few of them to fill this role except as lecturers to large classes—exactly the method we are attempting to replace. It would seem, then, the only feasible alternative is to use trainees as instructors. Thus, the central feature of the APSTRAT model is the instruction of trainees by other trainees, or peer instruction—a method laboratory and field tests have so far shown to be both practicable and effective.

With peer instruction, a one-to-one student-teacher ratio can be established that provides to both instructor and trainee the flexibility for self-pacing and rapid feedback for the latter's learning. With a job-performance orientation in a curriculum presented in a situation that simulates on-the-job training, and with a quality control system that demands mastery, the model does incorporate the desired principles and, at the same time, satisfies the various practical constraints.

The peer instruction method offers certain advantages especially appropriate for trainees who are low on the educational and aptitudinal spectrum. These men often approach a formal training situation with forebodings of failure based on their previous experiences, and often these forebodings are self-fulfilling prophesies, lack of confidence breeding lack of accomplishment. On the other hand, trainees receiving instruction from other trainees who have just mastered new skills well enough to be teaching them, are more likely to believe they, too, can attain mastery. In addition, differences in rank between trainee and instructor tend to inhibit communication to the detriment of the learning process. However, a man being instructed by a peer will feel more free to display ignorance or uncertainty and to ask necessary questions.

A further advantage—one which is particularly stressed by experimental subjects themselves—is that an individual is more eager to learn when he knows he is going to have to teach someone else what he is learning. This increased sense of responsibility is personally motivating and leads to greater group cohesion than is ordinarily found in training situations.

In addition to its advantages for the peer trainee, the peer instructional method is valuable to the peer instructor, for in the role of instructor a trainee has the necessity to review newly acquired knowledge and practice newly acquired skills.

Operation of the Model

An overview of the main elements of the model is best presented by beginning at the stage when the model is in full operation.

The course is organized around a series of job-performance stations representing the various duties that must be performed by a person competent in the job. At each station, an advanced trainee performs all job duties under the supervision of an instructor, while a trainee who is a new arrival at the station observes the job-performer at his job. In this way, the newcomer gains familiarity with the duties he himself will be performing. The period of time devoted to job-performance and observation at a station is dependent on the number of duties and the time required to perform them.

After familiarization with the job duties at the station, the trainee will go on to learn the skills necessary to perform the job. His teacher during this period is the trainee whose job-performance he observed. The period of time allocated to the learning phase is determined by the amount of time required for slower learners to reach mastery.

When both trainee and teacher are convinced that the trainee has mastered the skills necessary to perform a given task, they report to an instructor for the trainee's proficiency test. The instructor scores the trainee on his ability to perform the task on a pass-or-fail criterion.

If the trainee fails any test, he must review and practice the task until he can pass. When he passes, he proceeds with the mastering of the next task in the sequence, repeating the procedure of learning and testing until he has passed all proficiency checks appropriate to the station.

After he has passed all the proficiency checks for a given station, the trainee can be scheduled for job-performance. An incoming trainee will observe his performance, and the training cycle is repeated with the former trainee assuming the role of peer instructor.

This entire cycle—observation, learning, job-performance, and teaching—is repeated until the trainee completes the requirements of each station in the curriculum. An "administrative" buffer period may be added at the end of the cycle at each station to provide substitutes for job-performers and peer instructors who are absent.

The five-step sequence a trainee will go through is as follows:

1.	O	Observation
2.	L	Learning
3.	JP	Job-Performance
4.	T	Teaching
5.	A	Administration

With a daily input of trainees, and with the assumption that only one day is needed for each step in the sequence, the training schedule would look like the one in Table 1.

The number of O, L, JP, T, and A days will fluctuate according to the needs of any particular module. Table 2 shows a module in which there are two L days (and the corresponding two T days) and two A days.

It should be noted that the operational feasibility of the model requires the allocation of sufficient time to a station for even slow learners to attain mastery. However, the number of days in *all* stations must not exceed the total available time. The procedure adopted is initially to allocate to each station the amount of time allocated under the present system. Subsequently, the time maximum for any station can be reduced; or a station-maximum can be increased, if necessary, provided there is a compensating decrease elsewhere in the system.

Table 1

Training Schedule for "One-Day" Sequence

Training Day	Class 1	Class 2	Class 3	Class 4	Class 5
I	O				
II	L	O			
III	JP	L	O		
IV	T	JP	L	O	
V	A	T	JP	L	O
VI		A	T	JP	L
VII			A	T	JP
VIII				A	T
IX					A

Table 2

Training Schedule with Fluctuating Time Sequence

Training Day	Class 1	Class 2	Class 3	Class 4	Class 5
I	O				
II	L1	O			
III	L2	L1	O		
IV	JP	L2	L1	O	
V	T1	JP	L2	L1	O
VI	T2	T1	JP	L2	L1
VII	A1	T2	T1	JP	L2
VIII	A2	A1	T2	T1	JP
IX		A2	A1	T2	T1
X			A2	A1	T2
XI				A2	A1
XII					A2

Role of the Instructor

In the operation of this kind of model, the role of the instructor shifts to that of supervisor and administrator of an instructional system. The system relies on the regular instructors to maintain rigorous quality control, through spot-checks of instruction and tests of proficiency. Instructors also serve important functions in planning and priming the system.

In the planning stage, the instructors, as subject matter experts, have the major responsibility for redefining course objectives in performance terms, and designing task-modules to incorporate these performance requirements. They must also help develop proficiency tests and mastery standards for the defined requirements. In addition, they must make estimates of the time required for slow learners to master the skills in each

task-module. (Time estimates need not be precise, since the system allows for adjustment during the priming phase.)

In the priming stage of the system, the regular instructors are responsible for initial job-performance and instruction until they are replaced by trainees advancing through the system. (The start-up phase is gradual, one station being fully primed before the next station is started, and the old system is phased-out in a correspondingly gradual manner.) When all regular instructors have been replaced in these roles in a given station, and all necessary modifications have been made to obtain the stipulated levels of mastery within a minimum time, the next station can be started. Until the next station is started, graduates of a station return to the regular course for the rest of their training.

Although the model calls for a one-to-one teacher-student ratio, this arrangement may be temporarily suspended during the priming stage if the number of instructors, cannot support this ratio. A ratio of four- or five-to-one, in most cases, will not be excessive.

The priming stage of a station and the phasing-out of regular instructors based on a minimum-day module, are represented in Table 3.

Table 3

Priming of Station and Phasing Out of Instructors

("One-Day" Sequence)

Training Day	Class 1	Class 2	Class 3	Class 4
I	I-O			
II	I-L	I-O		
III	JP-3	I-L	I-O	
IV	T-3	JP-4	I-L	I-O
V	A1	T-4	JP-3	I-L
VI	A2	A1	T-3	JP-3
VII		A2	A1	T-4
VIII			A2	A1
IX				A2

The central symbols in each column (O, L, JP, T, A) are identical with the trainee's five-step sequences. The left-hand symbols (I) denote the teachers whom trainees observe and learn from. For example, on Day III, Class 3 has just entered the station and is observing Class 1 performing the job (JP), (this information is contained in the columns for both Classes 1 and 3), and Class 2 is on its learning day being taught by regular instructors.

This paper has described the objectives and constraints that led to the development of a peer-instructional model of training. A prototype of this model has proved successful in preliminary tests, but it remains to be seen whether the model is generally suitable for the wide variety of application for which it is intended. A full-scale test of the model is currently under way.

When the system is in operation, we will begin examination of the effects of incentive systems on trainee proficiency. In addition, we will initiate a study of ways of accelerating rapid learners through the system.

The training model involves changes in the nature of the roles of instructors and trainees. Since attitude changes have been evident in the preliminary research phases, we intend to examine the relationship between role and attitude more thoroughly.

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